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NATIONAL DAM SAFETY PROGRAM. COZY LAKE DAM (NJ00309) PASSAIC RI--ETC(U)
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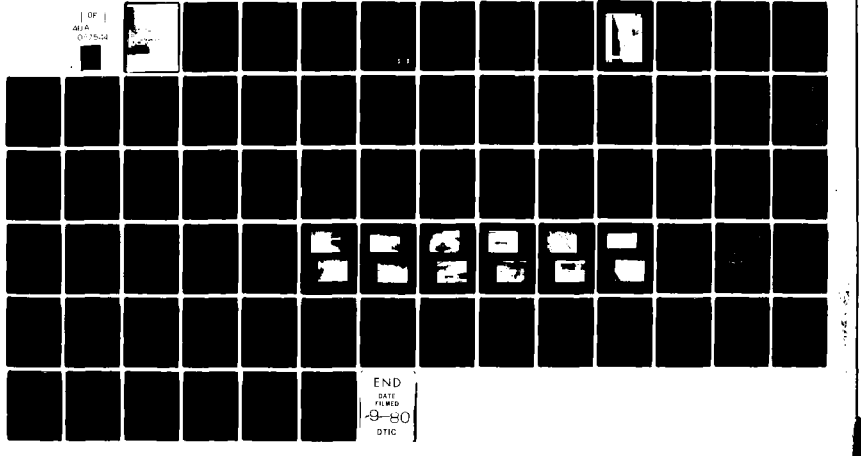

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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3. RECIPIENT'S CATALOG NUMBER:

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7. AUTHOR(s): ~~WARREN A. GUINAN~~
8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-79-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Anderson-Nichols, 6 London Road, Concord, N.H. 03301 (10) Warren A./Guinan
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: NJ Department of Environmental Protection, Division of Water Resources, P.O. Box CN029, Trenton, NJ 08625 (11)
12. REPORT DATE: Mar~~ch~~ 1980
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Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

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Dams
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Structural Analysis
Visual Inspection
National Dam Safety Program
Cozy Lake Dam , New Jersey
Erosion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE--2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

28 JUL 1980

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Cozy Lake Dam in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Cozy Lake Dam, initially listed as a high hazard potential structure, but reduced to a low hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate since a flow equivalent to one percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is the One Hundred Year Flood.) The low hazard potential classification means that in the event of failure of the dam, no loss of life and minimal economic loss is expected. However, to assure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken:

a. Repair the erosion protection on the embankment on both sides of the concrete spillway structure.

b. Repair the concrete spillway and remove the flashboard.

c. Provide erosion protection for the upstream slope of the embankment.

d. Remove trees from the embankment.

e. Install low-level outlet facilities.

f. Clear debris from the discharge channel between the spillway and the highway culvert immediately downstream.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

This report should prove of value to the dam's owner in that a format for future inspection is provided. Maintenance items, similar to the suggested remedial actions, will periodically develop, requiring attention by the owner.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

COZY LAKE DAM (NJ00309)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 8 November 1979 by Anderson-Nichols and Company, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Cozy Lake Dam, initially listed as a high hazard potential structure, but reduced to a low hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate since a flow equivalent to one percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is the One Hundred Year Flood.) The low hazard potential classification means that in the event of failure of the dam, no loss of life and minimal economic loss is expected. However, to assure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken:

a. Repair the erosion protection on the embankment on both sides of the concrete spillway structure.

b. Repair the concrete spillway and remove the flashboard.

c. Provide erosion protection for the upstream slope of the embankment.

d. Remove trees from the embankment.

e. Install low-level outlet facilities.

f. Clear debris from the discharge channel between the spillway and the highway culvert immediately downstream.

APPROVED: _____
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 20 JUN 80

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Cozy Lake Dam
Identification No.:	FED ID No. NJ00309
State Located:	New Jersey
County Located:	Morris
Stream:	East Branch of Rockaway River
River Basin:	Passaic
Date of Inspection:	November 8, 1979

ASSESSMENT OF GENERAL CONDITIONS

Cozy Lake Dam is a 56 year old earth dam and is in poor overall condition. It is small in size and should be downgraded to low hazard from its initial classification of high hazard. Trees and brush are growing on the crest and downstream slope of the dam. However, trespassing has destroyed some of the ground cover on the crest and downstream slope and erosion has occurred at a few locations.

The concrete spillway is badly surface eroded; the spillway abutments are eroded and spalled where in contact with the water. The steel flashboard bolted to the spillway is rusted; the middle sluice gate is rusted shut, and the other two are without gates. There was debris in the discharge channel between the spillway and the highway culvert immediately downstream of the dam. The spillway is capable of passing less than 1 percent of the 100-year flood without causing the dam to overtop, and is inadequate.

Cozy Lake Dam does not now pose a potential hazard to loss of life and only minimal property damage could occur if it should be breached. Should the owner wish to maintain the embankment, he should consider engaging a professional engineer qualified in the design and construction of dams to accomplish the following in the specified time frames: starting in the near future - design and implement repairs to the erosion protection on the embankment on both sides of the concrete spillway structure; design and implement repairs to the concrete spillway and remove the flashboard as suggested by NJDEP in 1977. In the future - specify and oversee procedures for removal of trees from the embankment; design and implement erosion protection for the upstream slope of the embankment; design and install low-level outlet facilities.

We also recommend that as a part of operating and maintenance procedures the owner should keep the discharge channel between the dam and the highway culvert free of debris.

ANDERSON-NICHOLS & COMPANY, INC.

Warren A. Guinan

Warren A. Guinan, P.E.
Project Manager
New Jersey No. 16848

OVERVIEW
COZY LAKE DAM

NOVEMBER 8, 1979

CONTENTS
PHASE I INSPECTION REPORT
COZY LAKE DAM N.J. NO. 22-33 FED ID NO. NJ00309

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION PROGRAM
COZY LAKE DAM
FED ID No. NJ00309

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Authority to perform the Phase I Safety Inspection of Cozy Lake Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 26 October 1979 under Contract No. FPM-39 dated 28 June 1978. This authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineers District, Philadelphia. The inspection discussed herein was performed by Anderson-Nichols & Company, Inc. on 8 November 1979.

b. Purpose. The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to the safety of Cozy Lake Dam and appurtenances based upon available data and visual inspection, and determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted.

1.2 Project Description

a. Description of Dam and Appurtenances. Cozy Lake Dam is a 56 year old earthfill dam which is approximately 610 feet long, has a structural height of 8 feet and hydraulic height of 7 feet. The topwidth of the dam varies from 3 feet to 5 feet. The downstream face slopes at approximately 2H:1V. The upstream face drops vertically for 1.5 feet and then slopes at approximately 5H:1V. A concrete spillway structure is located at the center of the dam. Concrete spillway abutments, 1 foot thick, define the 10-foot wide spillway opening, but flow through the spillway structure is limited by a 10-foot long, 1.5 foot high steel "flashboard" which is bolted to the concrete abutments. It has three openings, each 0.8 foot high by 1.2 feet wide, which were designed to function as sluice gates. Approximately 25 feet downstream of the spillway, flow passes beneath Cozy Lake Road through an elliptical concrete pipe (4.5 feet high by 7.5 feet wide). The watershed above the lake is flat to steeply sloping, and is partially wooded. Essential features of the dam are shown in Figures 1 and 2.

b. Location. The dam is located in the Township of Jefferson, Morris County, New Jersey, on the East Branch of the Rockaway River. It has coordinates of north latitude 41° 01' and west longitude 74° 30.3'. A location map is shown in Figure 3.

c. Size Classification. Cozy Lake Dam is classified as being small in size, as defined in the Recommended Guidelines for Safety Inspection of Dams, on the basis of its structural height of 8 feet, which is less than 40 feet, and its storage volume of 175 acre-feet which is less than 1000 acre-feet, but more than 50 acre-feet.

d. Hazard Classification. Visual inspection of the area downstream of the dam indicated that all the houses in the vicinity of the dam have first floor elevations of at least 15 feet above the streambed. A failure of Cozy Lake Dam could cause some damage to Cozy Lake Road and the culvert beneath it. Loss of life is unlikely. Cozy Lake Dam is thus classified as low hazard.

e. Ownership. Officials of Jefferson Township indicated that according to their tax records Cozy Lake Development Corporation owns the dam. Their most recent address for the president, Mr. George Fangman, was P.O. Box 4762, Hilton Head Island, South Carolina 29928. A letter was sent to that address explaining the inspection and no reply was received. Attempts to contact Mr. Fangman at an address and phone number in Stockholm, New Jersey, listed in NJDEP files and apparently active as late as August 1978, were also unsuccessful. The Stockholm office of Cozy Lake Development Corporation is defunct.

f. Purpose of Dam. The dam impounds a lake which is used for recreational purposes.

g. Design and Construction History. Reference data from NJDEP files indicates that the dam was constructed in 1924 by a Mr. Trusty. No plans, hydraulic or hydrologic data, for the construction of the dam were discovered.

h. Normal Operating Procedures. No formal operating procedures were revealed. From an inspection report and correspondence dated December 1977, recovered from NJDEP files, the steel flashboard now in place was also in place in 1977. At that time NJDEP requested that the flashboard be removed and the owner agreed to see that it was removed.

i. Site Geology. No site specific geologic information (such as borings) was available at the time the dam was inspected. Information derived from reports entitled "Engineering Geology of the Northeast Corridor, Washington, DC to Boston, MA" and the Geologic Map of New Jersey (Lewis & Kummel , 1912) indicates that Cozy Lake lies approximately at a border separating ground moraine overlying bedrock to the southeast from stratified glacial deposits in the form of sand and gravel to the northwest.

Although no outcrops were observed during inspection of this dam, the previously mentioned reports indicate that the underlying bedrock in the dam area consists of relatively unmetamorphosed sandstone and shale of Devonian age.

1.3 Pertinent Data

a. Drainage area - 1.84 square miles

b. Discharge at damsite - (cfs)

Maximum flood at damsite - unknown, water overtopped the dam next to the right spillway abutment in 1977.

Spillway capacity at normal pool elevation (as during inspection) - 3.0+

Spillway capacity at top of dam - 8.4

c. Elevation (ft. above NGVD)

Top of dam - 770.5

Maximum pool - design surcharge (100-yr) - 772.3

Recreation pool - (at the time of inspection) - 770.0

Spillway crest - 769.5

Streambed at centerline of dam - 763.4

Maximum tailwater - (estimated) - 767

d. Reservoir Length (feet)

Not applicable - pool is of very irregular shape

e. Storage (acre-feet)

Recreation pool - 150

Design surcharge (100 yr) - 232

Top of dam - 175

f. Reservoir Surface Area (acres)

Top of dam - 30.5

Spillway crest - 29.0

g. Dam

Type - earthfill

Length - 610+ feet

Height - hydraulic - 7 feet

structural - 8 feet

Topwidth - 3 to 5 feet

Side slopes - upstream - 1.5 feet vertical, then 5H:1V

- downstream - 2H:1V

Zoning - unknown

Impervious core - unknown

Cutoff - unknown

Grout curtain - unknown

h. Spillway

Type - concrete with steel flashboard

Length of weir - 10 feet

Crest elevation - (bottom of the openings in the permanently bolted steel flashboard) - 769.5 NGVD

- top of steel flashboard - 770.5 NGVD

SECTION 2
ENGINEERING DATA

2.1 Design

No original engineering design data or plans were found.

2.2 Construction

No original construction data were obtained.

2.3 Operation

No engineering operational data were revealed, with the exception of the correspondence described in Section 1.2 h. and included in Appendix 1.

2.4 Evaluation

a. Availability. A search of the New Jersey Department of Environmental Protection files and contact with community officials revealed a very limited amount of information (see Appendix 1).

b. Adequacy. The information available was such that the evaluation of this dam was based primarily on visual observations.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. Dam. It appears that erosion of this embankment has occurred next to both sides of the concrete spillway structure and has been repaired by placing concrete crudely on the crest, the downstream slope and above the waterline on the upstream slope. This concrete is severely cracked and has been undermined by erosion at both the downstream toe next to the discharge channel and at the waterline on the upstream slope. Sacks of cement, which have been hardened by exposure to the weather, have been placed on the crest for a distance of 10-15 feet west of the concrete erosion protection next to the west side of the spillway. The crest, upstream slope, and downstream slope of the embankment are covered with a dense growth of trees and brush. Wave erosion is occurring on the upstream slope at the waterline and has undermined several trees on the upstream slope. There is evidence of riprap on the upstream slope below lake level but not above lake level. Lack of vegetation and some erosion of the downstream slope of the embankment, apparently the result of trespassing, were noted at four locations. Anchors for a power pole have been installed on the crest of the dam near the east abutment.

b. Appurtenant Structures. The concrete spillway is badly surface eroded and the abutments are eroded and spalled where in contact with water. It is apparent that the embankment adjacent to the spillway, where the rough concrete has been placed, is overtopped regularly. The steel flashboard and sluice gates are badly rusted. The middle sluice gate appears to be rusted shut and the other two are without gates. Also, the gate slots in the flashboard are badly rusted.

c. Reservoir Area. The watershed immediately above the lake is flat to steeply sloping. It is partially wooded and partially cleared. The reservoir slopes appear to be stable. No evidence of significant sedimentation was observed. There are a number of homes on the shore of the lake.

d. Downstream Channel. There is some debris in the discharge channel between the spillway and the highway culvert immediately downstream of the spillway. Downstream of the highway culvert there is a dense growth of brush on both sides of the channel. Some trees overhang the channel.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No formal operating procedures were revealed.

4.2 Maintenance of Dam

No formal maintenance procedures for the dam were made known. From the condition of the embankment at the junction with the spillway abutments, and the presence of the sacks of cement on the crest, it is apparent that the owner, in the past, has attempted to stabilize the embankment.

4.3 Maintenance of Operating Facilities

No formal maintenance procedures for the operating facilities were discovered.

4.4 Warning System

No description of any warning system was found.

4.5 Evaluation of Operational Adequacy

Because of the lack of operation and maintenance procedures the remedial measures described in Section 7.2 should be implemented as described.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. Design Data. No hydrologic or hydraulic design data were found.

b. Experience Data. According to an inspection report dated December 5, 1977, prepared by the inspector John Garofalo from the State of New Jersey Bureau of Flood Plain Management, Dam Analysis Section, and a letter from John Garofalo to the Township of Jefferson dated March 17, 1978, Cozy Lake Dam experienced minor overtopping in December 1977 in the vicinity of the spillway structure. (See Appendix 1.)

c. Visual Observation. It appears that erosion caused by overtopping of the embankment next to both sides of the concrete spillway structure has been temporarily repaired by placing concrete crudely on the crest and downstream slope. This concrete is severely cracked and undermined, at both the downstream toe and the upstream slope. At the time of the inspection about 6 inches of water was flowing through the two sluice openings in the steel flashboard.

d. Overtopping Potential. The hydraulic/hydrologic evaluation for Cozy Lake Dam was based on a selected spillway design flood (SDF) equal to a 100-year flood in accordance with the range of test floods given in the evaluation guidelines for dams classified as low hazard and small in size. The 100-year flood has been determined by application of the SCS dimensionless unit hydrograph procedure to a 12-hour, 100-year precipitation storm of 6.3 inches. Hydrologic computations are given in Appendix 4. The routed 100-year peak discharge for the subject watershed is 2449 cfs.

The minimum elevation of the dam allows 1.0 foot of depth above the spillway crest before overtopping begins. Under this head, the spillway capacity is 8.4 cfs, which is less than the selected SDF. Flood routing calculations indicate that Cozy Lake Dam will be overtopped for 14 hours to a maximum depth of 1.8 feet under 100-year flood conditions. It is estimated that the dam can pass less than 1 percent of the 100-year flood without overtopping, thus the spillway is considered inadequate. It is apparent from this analysis and from visual observation that the embankment is regularly overtopped. Only flow over the embankment in the vicinity of the spillway structure will pass through the Cozy Lake Road culvert. The remainder of the overtopping discharge will flow directly over Cozy Lake Road and into the swampy area downstream.

SECTION 6
STRUCTURAL STABILITY

6.1 Visual Observations

The poor condition of the concrete which has been placed on the embankment next to the spillway structure for the purpose of erosion protection, and the undermining of this concrete by erosion at the waterline on the upstream slope and at the toe of the downstream slope, make this area susceptible to erosion if the dam should be overtopped.

Trees growing on the embankment could lead to serious seepage and erosion problems if a tree blows over and pulls out its roots or if a tree dies or is cut and its roots rot.

Erosion of the upstream slope of the dam at the waterline could lead to breaching of the dam if not controlled.

Lack of vegetation and erosion at at least four locations on the crest and downstream slope, apparently caused by trespassing, could result in more serious long-term erosion problems.

The installation of power pole anchors on the crest of the embankment near the east abutment could have detrimental effects on the resistance of the embankment to piping.

Based on the visual inspection alone, it is not possible to determine the character of the dam foundation or of the interior of the cross section of the embankment. It is, therefore, not possible to evaluate the factor of safety of the dam against slope failure.

6.2 Design and Construction Data

No design or construction data pertinent to the structural stability of the dam are available.

6.3 Operating Records

No operating records pertinent to the structural stability of the dam are available.

6.4 Post-Construction Changes

No record of post-construction changes pertinent to the structural stability of the dam is available.

6.5 Seismic Stability

This dam is in Seismic Zone 1. According to the Recommended Guidelines, dams located in Seismic Zone 1 "may be assumed to

present no hazard from earthquake provided static stability conditions are satisfactory and conventional safety margins exist." None of the visual observations made during the inspection are indicative of unstable slopes. However, because no data are available concerning the engineering properties of the embankment and foundation material for this dam, it is not possible to make a numerical evaluation of the factor of safety under static conditions.

SECTION 7
ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Cozy Lake Dam is 56 years old and is in poor condition.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection.

c. Urgency. Cozy Lake Dam does not now pose a potential hazard to loss of life and only minimal property damage could occur if it should be breached. However, should the owner wish to maintain the embankment he should consider implementing the recommendations as prescribed.

d. Necessity for Additional Data/Evaluation. The information available from the visual inspection is adequate to identify the potential problems which are listed in 7.2 a. below. These problems require the attention of a professional engineer qualified in the design and construction of dams who will have to make additional engineering studies to design or specify remedial measures. If left unattended, the problems could lead to failure of the structure.

7.2 Recommendations/Remedial Measures

a. Recommendations. The owner should retain a professional engineer qualified in the design and construction of dams to accomplish the following in the specified time frames.

Starting in the near future:

1. Design repairs for the erosion protection on the embankment on both sides of the concrete spillway structure.

2. Design and implement repairs to the concrete spillway and remove the flashboard as suggested by NJDEP in 1977.

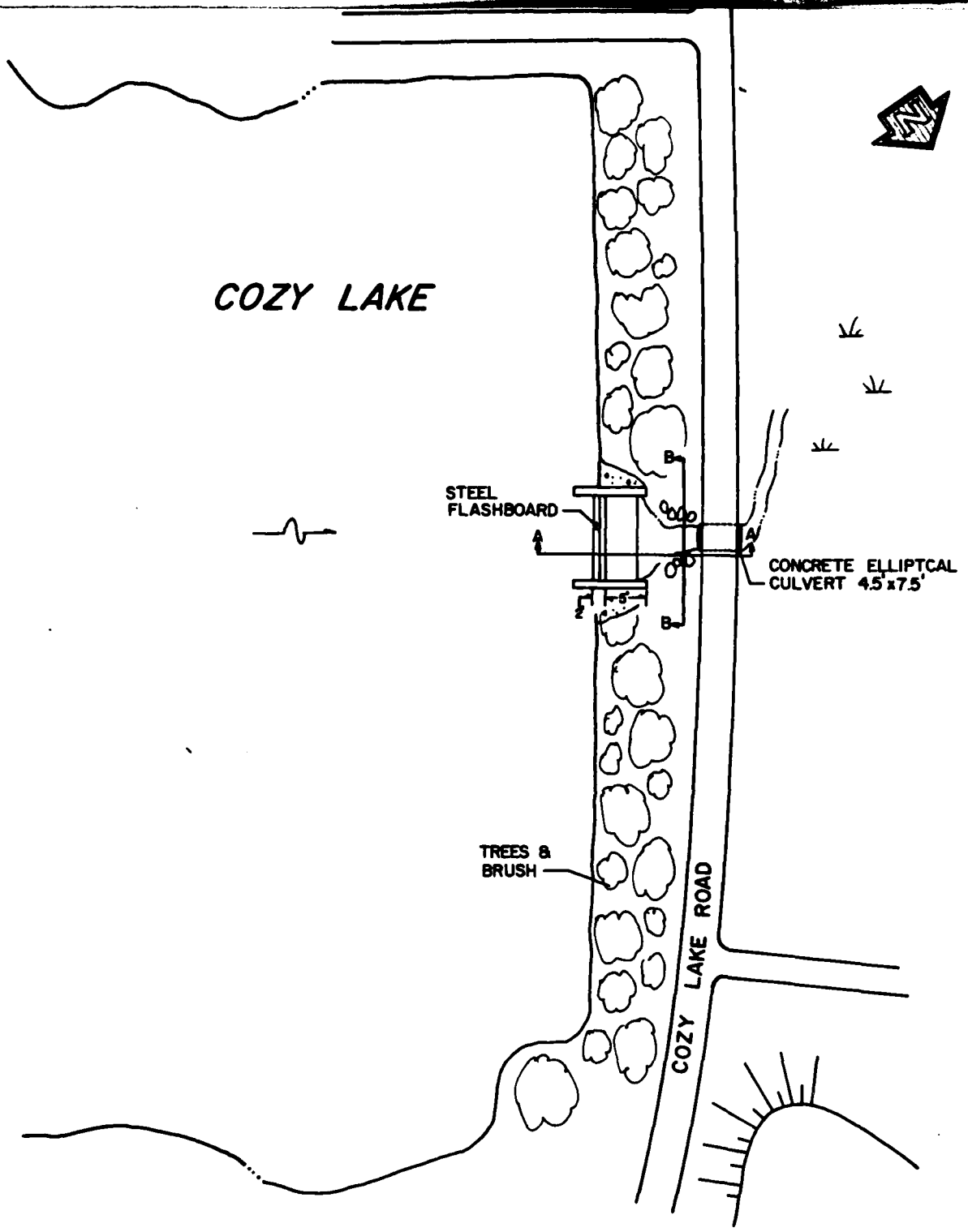
In the future:

1. Design erosion protection for the upstream slope of the embankment.

2. Specify and oversee procedures for removal of trees from the embankment.

3. Design and install low-level outlet facilities.

b. Operating and Maintenance Procedures. The owner should accomplish the following immediately: clear debris from the discharge channel between the spillway and the highway culvert immediately downstream.



DETAILS FROM FIELD INSPECTION NOV. 8, 1979

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIST. PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

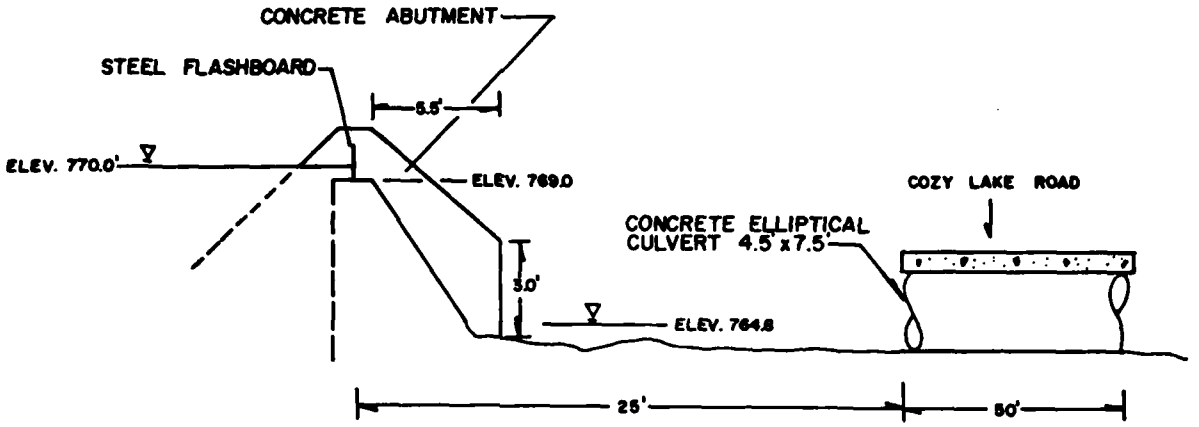
COZY LAKE DAM

EAST BRANCH ROCKAWAY RIVER NEW JERSEY

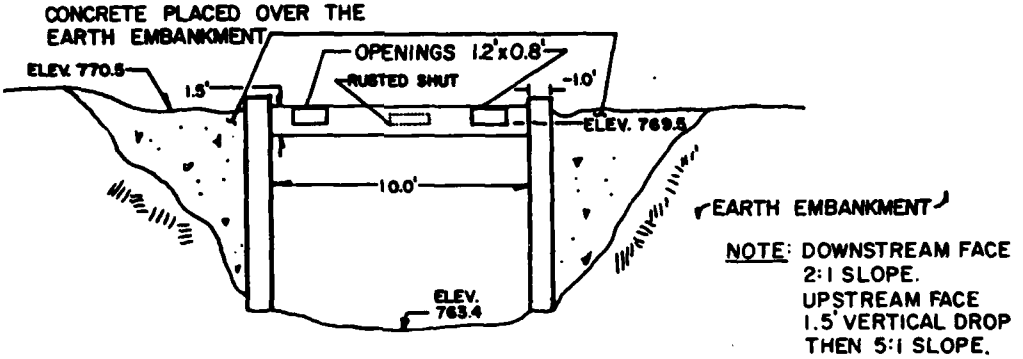
SCALE: NOT TO SCALE

DATE: FEBRUARY 1980

FIGURE 1



SECTION A-A



NOTE: DOWNSTREAM FACE
2:1 SLOPE.
UPSTREAM FACE
1.5' VERTICAL DROP
THEN 5:1 SLOPE.

ELEVATION B-B

DETAILS FROM FIELD INSPECTION NOV. 8, 1979

Anderson - Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIST. PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

COZY LAKE DAM

EAST BRANCH ROCKAWAY RIVER NEW JERSEY

			SCALE: NOT TO SCALE
			DATE: FEBRUARY 1980

FIGURE 2

Anderson-Nichols & Co., Inc.

CONCORD NEW HAMPSHIRE

U.S. ARMY ENGINEER DIST. PHILADELPHIA
CORPS OF ENGINEERS
PHILADELPHIA, PA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

COZY LAKES DAM
LOCATION MAP

ROCKAWAY BROOK NEW JERSEY

SCALE: SEE BAR SCALE
DATE: FEBRUARY 1980

SCALE IN MILES

0 10

MAP BASED ON STATE OF NEW JERSEY OFFICIAL HIGHWAY MAP AND GUIDE.

FIGURE-3

APPENDIX 1

ENGINEERING DATA

COZY LAKE DAM

INITIAL DAM INSPECTION REPORT

F.H.C. _____ Condition Rating _____

Sheet 1 of _____

Inspector: GAROFALO Date: 12-5-77

Name of Impoundment: COZEE LAKE

Dam No.: 309 U S Dam No.: 309 Map No.: 22-33

Location: USGS: _____ State Atlas: 22-33.8.6.6

Owner: _____

Address: _____

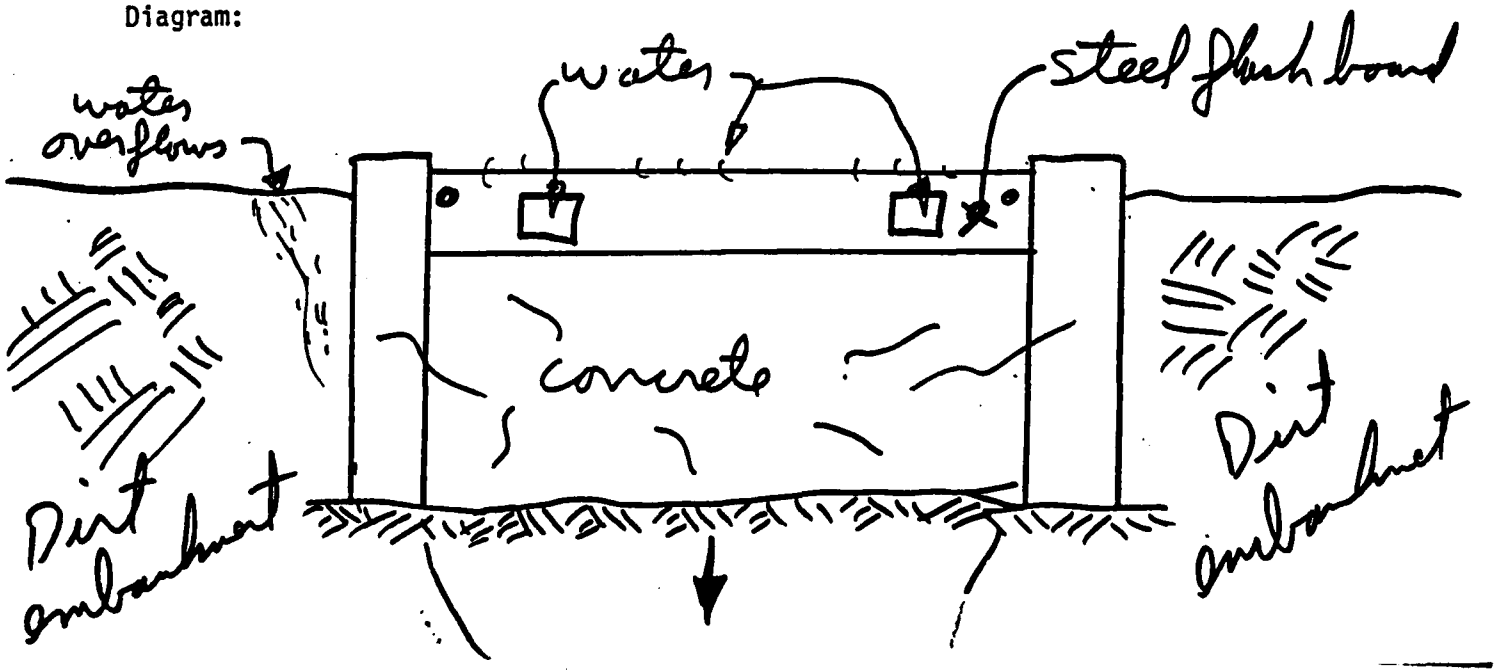
Stream: EAST BRANCH (TRIB. OF ROCKAWAY RIVER)

	SPILLWAY	MAIN	EMERGENCY N/A
Length:	10'		
Width:	2'		
Height:	8'		
Material:	CONCRETE		

Flashboards: Material STEEL Height 1' 7" How Many 1

Condition: APPEARED SOUND, HOWEVER, WATER OVERFLOWS EMBANKMENT

Diagram:



Dam No.:_____ Sheet 2 of _____

Embankments

Side Slopes: Upstream 2 Hor. To 1 Ver Downstream 2 Hor. To 1 Ver

Top Width: ± 2'

Height: 7'

Type: earthen (earthen, concrete, wood, etc.)

Freeboard: ± 4" (height from water surface to top of embankment)

Stabilization: vegetation (rip rapped, concrete, vegetation, etc.)

Condition: appeared stable

Diagram:

DOWNSTREAM CHANNEL AND/OR STILLING BASIN

Rip rapped: Yes X no _____

Side slopes: approx. vertical horizontal _____ vertical

Height to top of bank: 3' feet (stream invert to top of bank)

Stabilization and vegetation: Rip Rap and vegetated

Comments: Appeared stable with rock and natural vegetation. Water contained in banks and flows to an elliptical concrete pipe 8'x4' under roadway

Owner contacted on: _____ Letter Attached: _____

Recommendations: _____

Response: _____

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
P. O. BOX 2809
TRENTON, N. J. 08625

March 17, 1978

Township of Jefferson
Weldon Road
Lake Hopatcong, NJ 07849

Re: Dam No. 22-33

Attn: Joseph L. Carr

Gentlemen:

On December 5, 1977 an inspection of Cozzee Lake was made by engineers from the Bureau of Flood Plain Management Dam Analysis Section. The inspection revealed the following:

The spillway structure appears to be structurally sound as well as the training walls. The earthen embankment around the impoundment showed poor maintenance due to the excessive vegatation growing on it. The spillway had a s steel flashboard bolted to the top which raised the water surface causing water to overflow protions of the embankment. It is recommended that the steel flashboard be removed so that the water surface will be lowered to its normal elevation and prevent water from overtopping the embankment. Also the earthen embankment is to be depleted of excessive trees and other vegatation.

It is recommended that the repairs noted above are made immediately so that further complications can be avoided. Enclosed please find an application for a Dam Permit, which must be filed by the owner of the above referenced Dam before any repairs can be made.

If you have any questions, please contact me at (609) 292-2402.

Very truly yours,

John Garofalo
Dam Section
Bureau of Flood Plain Management

JG/chs

Enclosure
Enclosure

May 12, 1978

Cozzy Lake Development Corporation
c/o George Fangman
P.O. Box 47
Stockholm, NJ 07460

Re: Dam No. 22-33 (Cozzy Lake)

Gentlemen:

This is with reference to the above dam across East Branch of the Rockaway River in the Township of Jefferson, Morris County, New Jersey.

A recent inspection revealed that the dam and its related appurtenances are in need of repair.

Please be advised that an inspection of the subject dam is to be made by a licensed New Jersey Engineer in accordance to the enclosed checklist.

The checklist, outlining the recommended repairs, must be forwarded to this office no later than June 30, 1978.

Depending on the nature and the extent of the recommended repairs, a formal dam permit may be required from the Bureau of Flood Plain Management.

Very truly yours,

John Garofalo
Senior Engineer
Stream Encroachment Section
Bureau of Flood Plain Management

JG/chs

cc: Morris County Engineer
Jefferson Twp. Engineer & Clerk

APPENDIX 2

CHECK LIST
VISUAL INSPECTION

COZY LAKE DAM

Check List
Visual Inspection
Phase 1

Name Dam Cozy Lake Dam County Morris State New Jersey Coordinators NJDEP

Date(s) Inspection Nov. 8, 1979 Weather mild, cloudy Temperature 55° F

Pool Elevation at Time of Inspection 770 feet NGVD Tailwater at Time of Inspection 764.8 feet NGVD

Inspection Personnel:

Warren Guinan

Ronald Hirschfeld

Stephen Gilman

Janusz Czyzowski

Gilman/Hirschfeld Recorder

COAL LAKE DAM, NJ

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	At several locations there is evidence of trespassing and bare areas on crest and downstream slope.	Control trespassing on dam.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical alignment fair to poor. Horizontal alignment good.	
RIPRAP FAILURES	Evidence of riprap below lake surface but none above lake surface on upstream slope. Significant erosion of upstream slope at waterline.	Repair erosion and provide erosion protection.

COZ. LAKE DAM, NJ

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RAILINGS	No railings.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Intense erosion at left and right edges of spillway. Has been repaired with crudely placed concrete which is severely cracked and undermined at both downstream toe and at waterline on upstream slope.	Repair erosion and provide erosion protection.
ANY NOTICEABLE SEEPAGE	None observed.	
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Poor condition - surface eroded and spalled exposing coarse aggregate. Abutments are badly eroded and spalled where in contact with water.	Engage engineer to design and implement spillway repairs.
APPROACH CHANNEL	Wide and unobstructed.	
DISCHARGE CHANNEL	Debris in channel between spillway and culvert under road immediately downstream of dam. Channel downstream of road has heavy brush on banks.	Clear debris from channel between spillway and culvert.
BRIDGE AND PIERS	None.	
GATES AND OPERATION EQUIPMENT	Steel flashboard and steel sluice gates are badly rusted. Middle sluice gate appears rusted shut. No indication of recent operation. Gate slots are badly rusted. Bolts holding flashboard in place are badly rusted.	See "concrete sill" above.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gently sloping. Many cottages on shoreline.	
SEDIMENTATION	No evidence of significant sedimentation observed.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	There is a highway culvert approximately 25 ft. downstream of the spillway crest. Downstream of the culvert there is a dense growth of brush on both sides of the channel.	
SLOPES	Channel downstream of the Cozy Lake Road is almost flat.	
APPROXIMATE NO. OF HOMES AND POPULATION	There are few houses located along downstream channel with first floor elevations at least 15 feet above the streambed.	Because of their locations there is no possibility of damage caused by a dam failure.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER	None observed.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	No original plans were found. Plans for the report were developed from visual inspection.
REGIONAL VICINITY MAP	Prepared for this report.
CONSTRUCTION HISTORY	No recorded description. According to reference data, dams in New Jersey, No. 22-33 from NJDEP files Cozy Lake Dam was constructed in 1924 by Mr. Trusty.
TYPICAL SECTIONS OF DAM	Prepared for this report from visual inspection.
HYDROLOGIC/HYDRAULIC DATA	Not available.
OUTLETS - PLAN	Not found.
- DETAILS	Not found.
- CONSTRAINTS	Not found.
- DISCHARGE RATINGS	Not found.
RAINFALL/RESERVOIR RECORDS	Not found.

ITEM	REMARKS
DESIGN REPORTS	None revealed.
GEOLOGY REPORTS	None revealed.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None revealed.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None revealed.
POST-CONSTRUCTION SURVEYS OF DAM	None revealed.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SERVICES	Unknown.
MODIFICATIONS	None discovered.
HIGH POOL RECORDS	None revealed.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None found.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	According to an inspection report dated 12-5-77, prepared by inspector John Garofalo from the state of New Jersey Bureau of Flood Plain Management, Cozy Lake Dam experienced minor overtopping in December 1977 in the vicinity of the spillway structure.
MAINTENANCE OPERATION RECORDS	None found.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	No original plans were available. Cross section for this report was prepared from visual inspection.
OPERATING EQUIPMENT	None.
PLANS & DETAILS	None.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.84 square miles, hilly, wooded

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 769.5 feet NGVD (145 (acre-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not applicable

ELEVATION MAXIMUM DESIGN POOL: 772.3 ft. NGVD (100 year flood)

ELEVATION TOP DAM: 770.5 ft. NGVD

CREST: Concrete spillway structure with bolted steel flashboard

a. Elevation 769.5 ft. NGVD

b. Type Concrete step with steel flashboard

c. Width Concrete - 2 feet, flashboard -0.5"±

d. Length 10 feet

e. Location Spillover Center of dam

f. Number and Type of Gates Three openings in the flashboard, one rusted shut, two others without gates

OUTLET WORKS: None

a. Type

b. Location

c. Entrance Inverts

d. Exit Inverts

e. Emergency Draindown Facilities

HYDROMETEORLOGICAL GAGES: None

a. Type

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 8.4 cfs

APPENDIX 3

PHOTOGRAPHS

COZY LAKE DAM

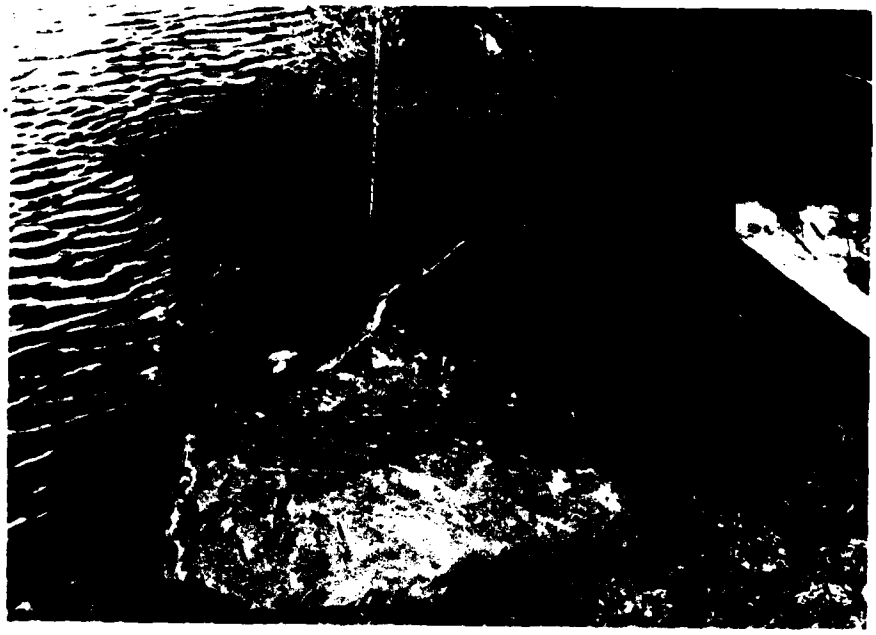
NOVEMBER 8, 1979
LOOKING NORTHEAST ALONG CREST OF DAM FROM THE SPILLWAY.

NOVEMBER 8, 1979
LOOKING SOUTHWEST ALONG CREST OF DAM
FROM THE SPILLWAY.

NOVEMBER 8, 1979
VIEW OF THE UPSTREAM FACE OF THE DAM.

NOVEMBER 8, 1979
VIEW OF THE DOWNSTREAM FACE OF THE DAM.

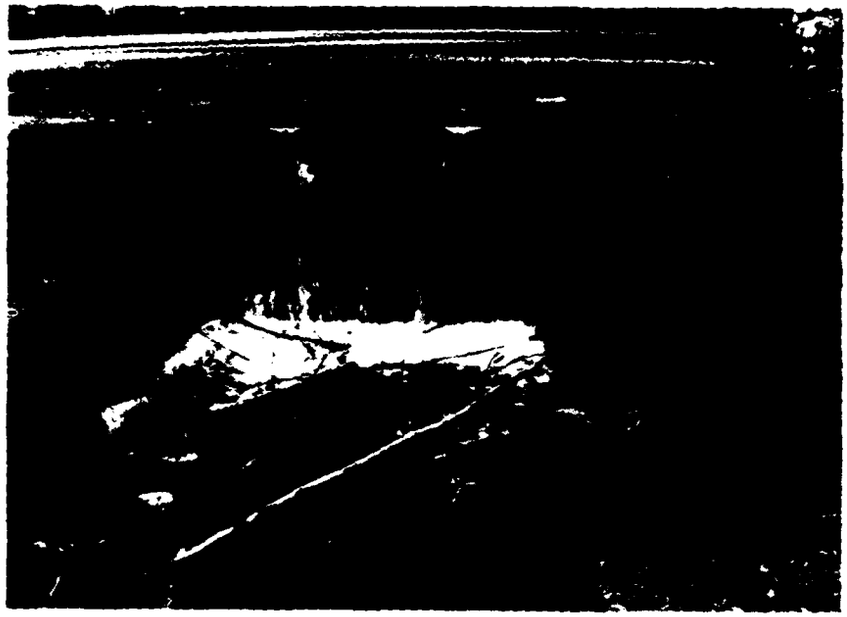
COZY LAKE DAM



NOVEMBER 8, 1979
EROSION AT JUNCTION OF EMBANKMENT AND SPILLWAY.

NOVEMBER 8 1979
VIEW OF UNDERMINED NORTHEAST BANK OF DISCHARGE CHANNEL IMMEDIATELY DOWNSTREAM OF SPILLWAY.

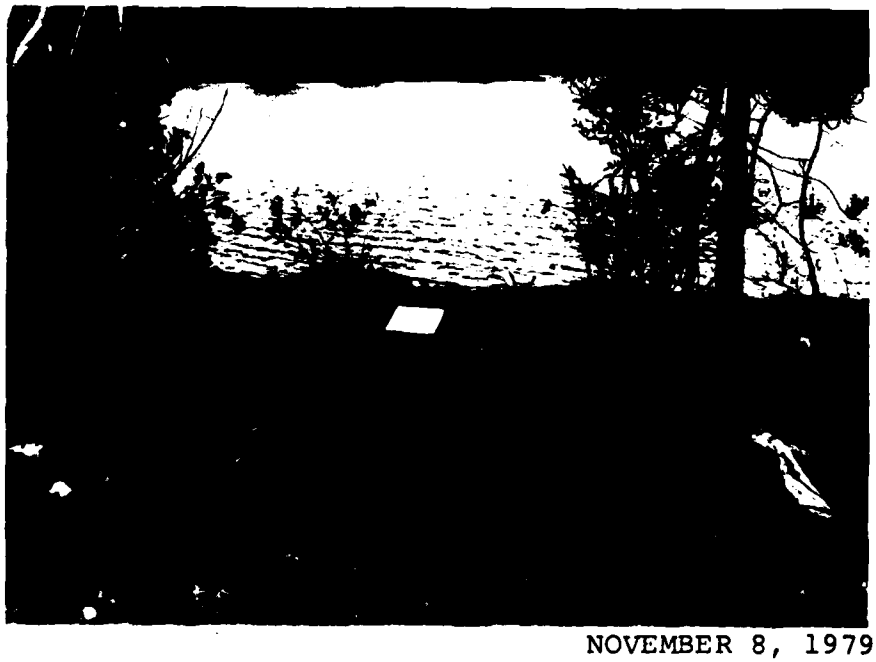
COZY LAKE DAM



NOVEMBER 8, 1979
DISCHARGE CHANNEL AND DOWNSTREAM FACE OF THE SPILLWAY VIEWED FROM THE TOP OF CULVERT DOWNSTREAM OF THE DAM.

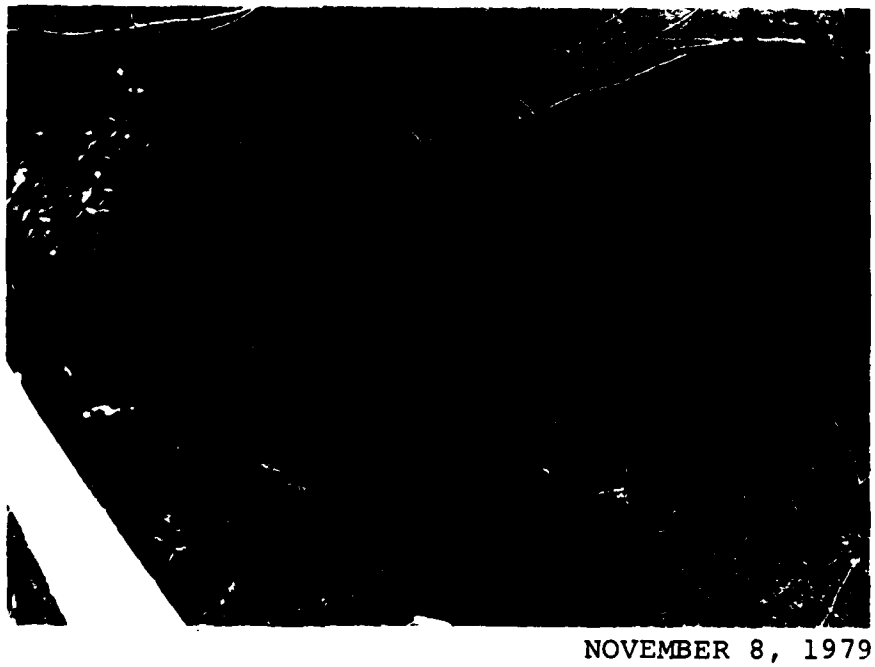
NOVEMBER 8, 1979
CULVERT UNDER THE HIGHWAY VIEWED FROM THE NORTHEAST SIDE OF THE SPILLWAY.

NOVEMBER 8, 1979
HEAVY BRUSH AND TREES OVERGROWING THE CREST AND DOWNSTREAM FACE OF DAM.



NOVEMBER 8, 1979
EVIDENCE OF TRESPASSING AND LACK OF VEGETATION ON CREST AND DOWNSTREAM FACE APPROXIMATELY 200' NORTHEAST OF THE SPILLWAY.

NOVEMBER 8, 1979
VIEW OF THE RESERVOIR LOOKING EAST FROM THE SPILLWAY.

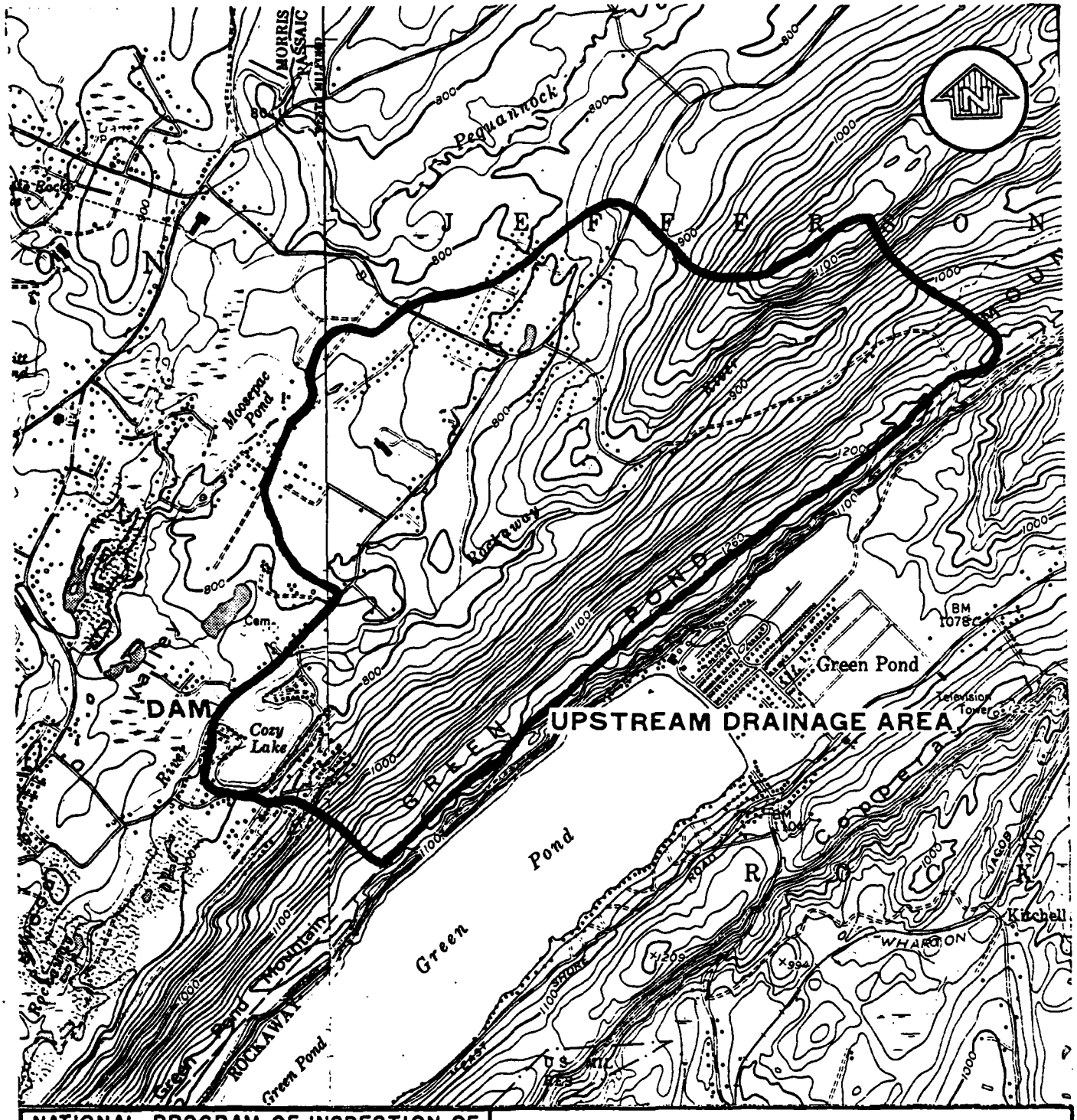


NOVEMBER 8, 1979
DOWNSTREAM CHANNEL AND LOW SWAMPY AREA COVERED WITH BRUSH AND TREES LOOKING WEST FROM THE HIGHWAY CULVERT.

APPENDIX 4

HYDROLOGIC COMPUTATIONS

COZY LAKE DAM



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

COZY LAKE DAM

JEFFERSON TOWNSHIP, NEW JERSEY

REGIONAL VICINITY MAP

FEBRUARY 1980

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

ANDERSON-NICHOLS & CO., INC. - CONCORD, N.H.

MAP BASED ON U.S.G.S. 7.5 MINUTE QUADRANGLE SHEETS. FRANKLIN, NJ 1954. REVISED 1971. AND NEWFOUNDLAND, NJ 1954. REVISED 1971.

Anderson-Nichols & Company, Inc.

Subject H54 / 1

Sheet No. 1 of 8
Date 11/19/79
Computed JLL
Checked EDD

JOB NO. 3409-04

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

COZY LAKE DAM – COMPUTATION OF TIME OF CONCENTRATION

FLOW OVERLAND : $L = 2300$ FT
$S = .13043$ S-SLOPE

CHANNEL FLOW : $L = 8200$ FT
$S = .01585$

1. THE TEXAS HIGHWAY VELOCITY DATA FROM DESIGN OF SMALL DAMS

FLOW OVER LAND :

13% WOODLAND → 2.5 FT/SEC

$\frac{2300 \text{ FT}}{2.5 \text{ FT/SEC}} = 657 \text{ SEC} = .18 \text{ hr}$

CHANNEL FLOW :

1.58 % FROM TABLE BB MAR 1953 → 2 FT/SEC

$\frac{8200 \text{ FT}}{2 \text{ FT/SEC}} = 4100 \text{ SEC} = 1.14 \text{ hr}$

TOTAL T_c = 1.32 hr

2. THE SCS TR-55 – WESTON "STORM WATER MANAGEMENT"

AVERAGE VELOCITY FOR OVERLAND FLOW → .9 FT/S

$T_c = \frac{2300 \text{ FT}}{2600 \cdot .9 \text{ FT/SEC}} = .71 \text{ hr}$

CHANNEL FLOW : $n = .05$ $R = 1.9$

$V = \frac{1.49}{n} \cdot R^{2/3} \cdot S^{1/2}$

$V = \frac{1.49}{.05} \cdot 1.9^{2/3} \cdot .01585^{1/2} = 5.7 \text{ FT/SEC}$

$T_c = .4$ hr

TOTAL $T_c = .71 + .4$ 1.11 hr

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

GOZY LAKE DAM – COMPUTATION OF TIME OF CONCETRATION (CONT'D)

3. METHOD FROM SOIL AND WATER CONSERVATION ENGT. INCLUDING BOTH OVERLAND AND CHANNER FLOW.

$L = 10,500$ FT

$Y = 4\%$ (SLOPE)

$$.6\,Tc = \frac{L^{.8}(S+1)^{1.67}}{9000\,Y^{.5}}$$

$$= 1.48 \text{ hrs}$$

$$S = \frac{1000}{N} - 10$$

$N = 70$ FOR WOODS

$S = 4.3$

$Tc = 2.46$ hr

AVERAGE TIME OF CONCENTRATION

$$\frac{1.32 + 1.11 + 2.46}{3} = 1.63 = Tc$$

JOB # 3409-04
DATE 11/15/79
COMPUTED BY J.G.
CHECKED: TOD

COZY LAKE DAM - X-SECTION ALONG THE DAM

ELEVATION (FT MSL)

790
780
770

0
100
500
600
700

DISTANCE IN FEET

Anderson-Nichols & Company, Inc.

Subject H & H

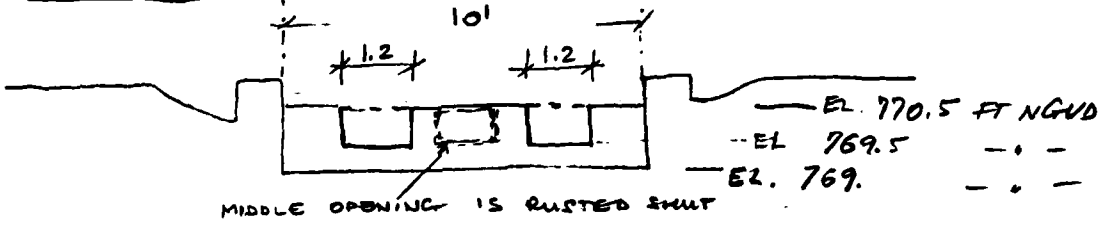
Sheet No. 4 of 8
Date 11-16-79
Computed
Checked FDD

JOB NO. 3409 - 04

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

COZY LAKE DAM - RATING CURVE COMPUTATION

1. FLOW OVER THE SPILLWAY ONLY



$C = 3.5$ $\quad Q = C \cdot L \cdot H^{3/2}$

	ELEV. [FT. NGVD]	H_1 [FT]	L_1 [FT]	H_2 [FT]	L_2 [FT]	Q_1 [CFS]	Q_2 [CFS]	TOTAL Q [CFS]
	769.5	0						
	770.0	.5	2.4			3.0		3.0
TOP OF DAM	770.5	1.0	"			8.4		8.4
	771.0	1.5	"	.5	7.6	15.4	9.4	25
	771.2	1.7	"	.7	"	18.6	15.6	34.
	771.4	1.9	"	.9	"	22.	22.7	45.
	771.6	2.1	"	1.1	"	25.6	30.7	56.
	771.8	2.3	"	1.3	"	29.3	39.4	69.
	772.0	2.5	"	1.5	"	33.2	48.9	82.
	772.5	3.0	"	2.0	"	43.6	75.2	119.

Anderson-Nichols & Company, Inc. Subject H & H

Sheet No. 5 of 8
Date 4-16-79
Computed J.G.
Checked FRDJ

JOB NO. 3409-04

COZY LAKE DAM - RATING CURVE COMPUTATION (CONT'D)

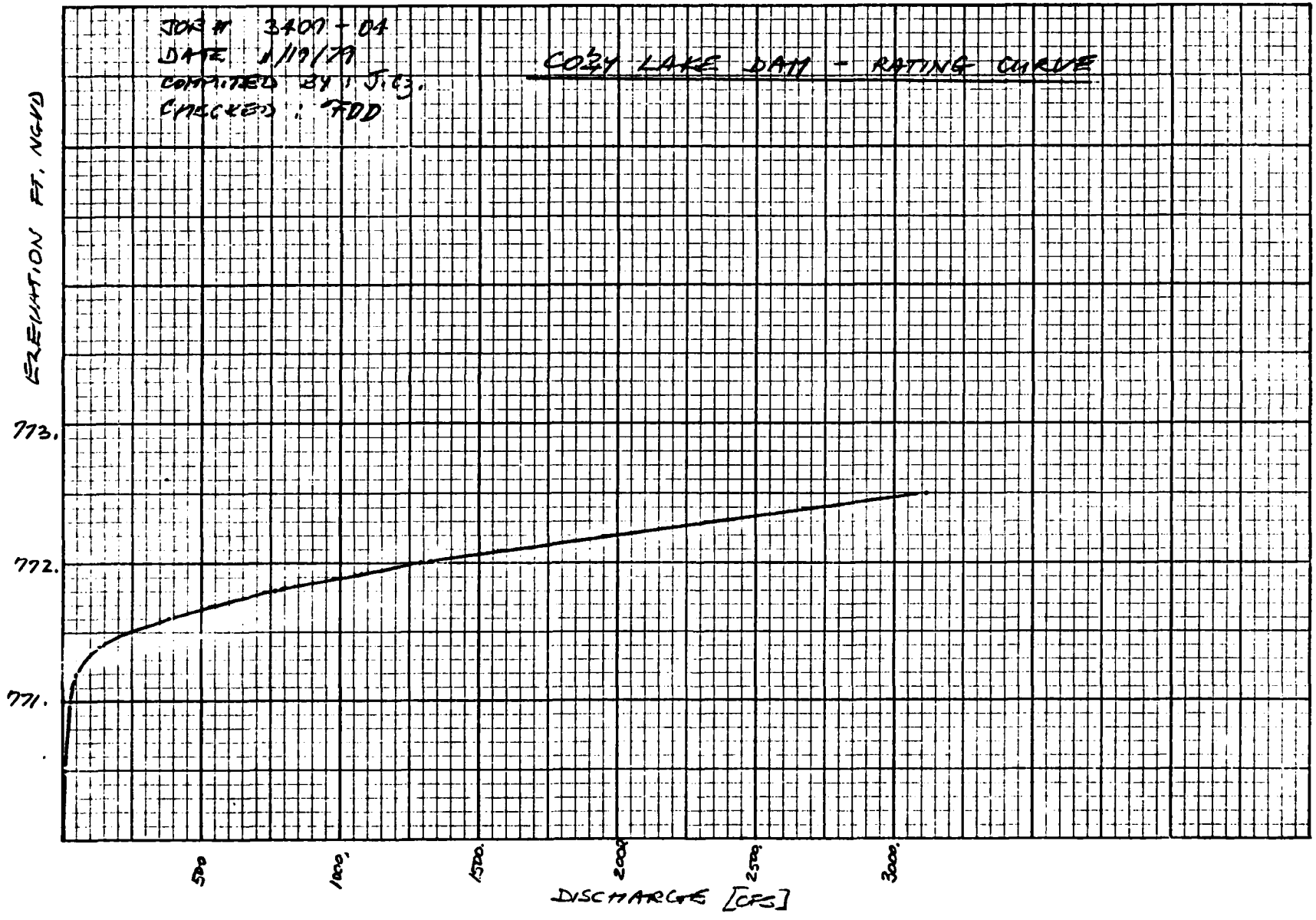
2. FLOW OVER THE DAM ONLY (WITHOUT SPILLWAY)

$C = 2.8$ $\quad Q = C \cdot L \cdot H^{3/2}$

ELEV. (FT. NGVD)	H (FT.)	L (FT)	H (FT.)	L (FT)	H (FT)	L (FT)	TOTAL Q (CFS)
770.5	0						0
771.0	.5	8					8
771.2	.7	9					15
771.4	.9	10	.3	30	.1	550	87
771.6	1.1	11	.5	40	.3	555	330.
771.8	1.3	15	.7	50	.5	560	699.
772.0	1.5	20	.9	75.	.7	565	1209.
772.5	2.0	25	1.4	90.	1.3	575	3002.

SUMMARY

	ELEV. (FT. NGVD)	TOTAL Q (CFS)
	769.5	0
	770.	3.0
TOP OF DAM	770.5	8.4
	771.0	33.
	771.2	49.
	771.4	132.
	771.6	386.
	771.8	768.
	772.0	1290.
	772.5	3120.



Anderson-Nichols & Company, Inc.

Subject H & H

Sheet No. 7 of 8
Date 11-19-79
Computed JLJ
Checked EDV

JOB NO. 3409 - 04

SQUARES 1/4 IN. SCALE

COZY LAKE DAM - STORAGE CALCULATION

NORMAL STORAGE (SPILLWAY CREST — 769.5 FT NGVD) — 116 AC-FT

116 AC-FT WAS OBTAINED BY ESTIMATING AVERAGE DEPTH OF RESERVOIR — 5 FT AND PLANIMETERE SURFACE OF RESERVOIR FROM QUAD SHEET — 29. AC .

USING "FRUSTRUM OF PYRAMID EQUTION" AND PLANIMETERED SURFACE AREAS STORAGE - ELEVATION RELATIONSHIP WAS DEVELOP.

$$\Delta V = \frac{1}{3} h \left(b_1 + b_2 + \sqrt{b_1 b_2} \right)$$

h — ELEV. ABOVE NORMAL POOL
b_1 - NORMAL POOL SURFACE
b_2 - ENLARGE POOL - " -

ELEV. FT. NGVD		b_1 (AC)	b_2 (AC)	h FT	ΔV	TOTAL V (AC-FT)
769.5		29.				145.
770.5	TOP OF DAM	29.	30.5	1.	29.7	175
772.		29.	32.0	2.5	76.2	~221.
773.		29.	33.5	3.5	109.3	~254.

Anderson-Nichols & Company, Inc.

Subject H & H

Sheet No. 8 of 8
Date 1-23-80
Computed [illegible]
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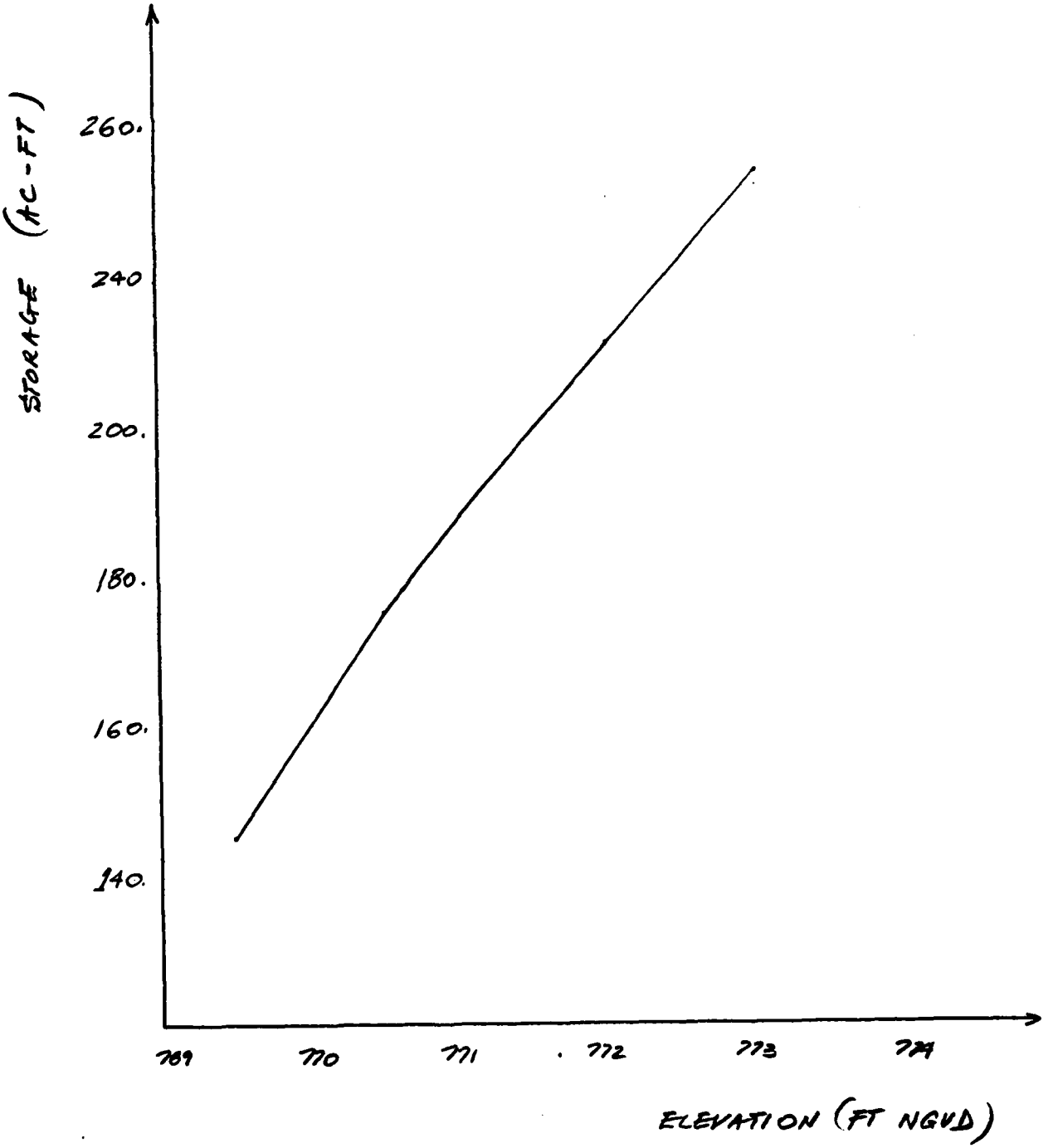
JOB NO. 3409 -04

SQUARES 1/4 IN. SCALE

COZY LAKE DAM — STORAGE-ELEVATION CURVE



HEC-1 OUTPUT

OVERTOPPING ANALYSIS

COZY LAKE DAM

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                 A1JOB 3409-84 COZY LAKE WOODSTOCK,N.J. NJ# 22-33 USW 309
    2                 A2CONVERTOPINC ANALYSIS,ANDERSON-NICHOLS & CO. INC.
    3                 A3TEST STORM 100-YEAR 12-HOUR RAINFALL
    4                 B    120       0       10       0       0       0       0       0       0       0
    5                 B1     5
    6                 J      1       1       1
    7                 J1    1.
    8                 K                A1                                     1       1
    9                 K1DEVELOP INFLOW HYDROGRAPH
   10                 M                ?     1.84                             1.                      1
   11                 C     72
   12                 C1  .030    .030    .030    .030    .030    .030    .030    .030    .030    .030
   13                 C1  .030    .030    .030    .031    .031    .031    .031    .031    .056    .056
   14                 C1  .056    .056    .056    .056    .056    .056    .056    .067    .067    .067
   15                 C1  .133    .133    .133    .217    .535   1.280    .535    .217    .217    .133
   16                 C1  .133    .133    .067    .067    .067    .056    .056    .056    .056    .056
   17                 C1  .056    .056    .056    .056    .031    .031    .031    .031    .031    .031
   18                 C1  .030    .030    .030    .030    .030    .030    .030    .030    .030    .030
   19                 C1  .030    .030
   20                 Y                                                      1.0     .10
   21                 N                .98
   22                 X2   -7.
   23                 K      1         A2                                     1       1
   24                 K1ROUTE INFLOW HYDROGRAPH THROUGH IMPOUNDMENT
   25                 Y                                       1       1
   26                 Y1     1                                              -769.6      -1
   27                 Y4 769.5    770.    770.5    771.    771.2    771.4   771.6   771.8    772.    772.5
   28                 Y5    0.      3.      8.4     33.     49.     132.     386.    768.   1290.   3100.
   29                 1S  145.    175.    221.    254.
   30                 1E 769.5   770.5    772.    773.
   31                 1I 769.5
   32                 1O 770.5
   33                 K     99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	A1
ROUTE HYDROGRAPH TO	A2
END OF NETWORK	

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80/01/31.
TIME= 09.12.05.

JOB 3409-84 COZY LAKE WOODSTOCK,N.J. NJ# 22-33 USR 309
OVERTOPING ANALYSIS,ANDERSON-NICHOLS & CO. INC.
TEST STORM 100-YEAR 12-HOUR RAINFALL

JOB SPECIFICATION

IT	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
120	0	10	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

DEVELOP INFLOW HYDROGRAPH

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A1	0	0	0	0	1	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	1.84	0.00	1.84	1.00	0.000	0	1	0

PRECIP DATA

PP	STORM	DAJ	DAK
72	0.00	0.00	0.00

PRECIP PATTERN

.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.06	.06
.06	.06	.06	.06	.06	.06	.06	.07	.07	.07
.13	.13	.13	.22	.54	1.28	.54	.22	.22	.13
.13	.13	.07	.07	.07	.06	.06	.06	.06	.06
.06	.06	.06	.06	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03								

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.10	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .00

RECESSION DATA

STRTQ= -3.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 31 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .90 VOL= 1.00

58.	172.	353.	587.	762.	830.	827.	745.	643.	500.
379.	285.	222.	175.	139.	105.	81.	62.	48.	37.
29.	23.	17.	13.	11.	8.	7.	5.	4.	2.
1.									

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.03	0.00	.03	6.	1.01	10.10	61	.03	.01	.02	230.
1.01	.20	2	.03	0.00	.03	6.	1.01	10.20	62	.03	.01	.02	204.
1.01	.30	3	.03	0.00	.03	6.	1.01	10.30	63	.03	.01	.02	181.
1.01	.40	4	.03	0.00	.03	6.	1.01	10.40	64	.03	.01	.02	163.
1.01	.50	5	.03	0.00	.03	6.	1.01	10.50	65	.03	.01	.02	148.
1.01	1.00	6	.03	0.00	.03	6.	1.01	11.00	66	.03	.01	.02	136.
1.01	1.10	7	.03	0.00	.03	6.	1.01	11.10	67	.03	.01	.02	127.
1.01	1.20	8	.03	0.00	.03	6.	1.01	11.20	68	.03	.01	.02	120.
1.01	1.30	9	.03	0.00	.03	6.	1.01	11.30	69	.03	.01	.02	115.
1.01	1.40	10	.03	0.00	.03	6.	1.01	11.40	70	.03	.01	.02	112.
1.01	1.50	11	.03	0.00	.03	6.	1.01	11.50	71	.03	.01	.02	109.
1.01	2.00	12	.03	0.00	.03	6.	1.01	12.00	72	.03	.01	.02	107.
1.01	2.10	13	.03	0.00	.03	6.	1.01	12.10	73	0.00	0.00	0.00	105.
1.01	2.20	14	.03	0.00	.03	6.	1.01	12.20	74	0.00	0.00	0.00	101.
1.01	2.30	15	.03	0.00	.03	6.	1.01	12.30	75	0.00	0.00	0.00	95.
1.01	2.40	16	.03	0.00	.03	6.	1.01	12.40	76	0.00	0.00	0.00	87.
1.01	2.50	17	.03	0.00	.03	6.	1.01	12.50	77	0.00	0.00	0.00	76.
1.01	3.00	18	.03	0.00	.03	6.	1.01	13.00	78	0.00	0.00	0.00	65.
1.01	3.10	19	.06	0.00	.06	6.	1.01	13.10	79	0.00	0.00	0.00	53.
1.01	3.20	20	.06	0.00	.06	6.	1.01	13.20	80	0.00	0.00	0.00	43.
1.01	3.30	21	.06	0.00	.06	6.	1.01	13.30	81	0.00	0.00	0.00	35.
1.01	3.40	22	.06	0.00	.06	6.	1.01	13.40	82	0.00	0.00	0.00	28.
1.01	3.50	23	.06	0.00	.06	6.	1.01	13.50	83	0.00	0.00	0.00	23.
1.01	4.00	24	.06	0.00	.06	6.	1.01	14.00	84	0.00	0.00	0.00	19.
1.01	4.10	25	.06	0.00	.06	6.	1.01	14.10	85	0.00	0.00	0.00	16.
1.01	4.20	26	.06	0.00	.06	6.	1.01	14.20	86	0.00	0.00	0.00	13.
1.01	4.30	27	.06	.03	.02	8.	1.01	14.30	87	0.00	0.00	0.00	12.
1.01	4.40	28	.07	.05	.02	14.	1.01	14.40	88	0.00	0.00	0.00	10.
1.01	4.50	29	.07	.05	.02	29.	1.01	14.50	89	0.00	0.00	0.00	9.
1.01	5.00	30	.07	.05	.02	55.	1.01	15.00	90	0.00	0.00	0.00	8.
1.01	5.10	31	.13	.12	.02	95.	1.01	15.10	91	0.00	0.00	0.00	8.
1.01	5.20	32	.13	.12	.02	147.	1.01	15.20	92	0.00	0.00	0.00	7.
1.01	5.30	33	.13	.12	.02	212.	1.01	15.30	93	0.00	0.00	0.00	7.
1.01	5.40	34	.22	.20	.02	294.	1.01	15.40	94	0.00	0.00	0.00	6.
1.01	5.50	35	.54	.52	.02	411.	1.01	15.50	95	0.00	0.00	0.00	6.
1.01	6.00	36	1.26	1.24	.02	621.	1.01	16.00	96	0.00	0.00	0.00	6.
1.01	6.10	37	.54	.52	.02	943.	1.01	16.10	97	0.00	0.00	0.00	6.
1.01	6.20	38	.22	.20	.02	1375.	1.01	16.20	98	0.00	0.00	0.00	6.
1.01	6.30	39	.22	.20	.02	1861.	1.01	16.30	99	0.00	0.00	0.00	6.
1.01	6.40	40	.13	.12	.02	2250.	1.01	16.40	100	0.00	0.00	0.00	6.
1.01	6.50	41	.13	.12	.02	2450.	1.01	16.50	101	0.00	0.00	0.00	6.
1.01	7.00	42	.13	.12	.02	2490.	1.01	17.00	102	0.00	0.00	0.00	6.
1.01	7.10	43	.07	.05	.02	2380.	1.01	17.10	103	0.00	0.00	0.00	6.
1.01	7.20	44	.07	.05	.02	2177.	1.01	17.20	104	0.00	0.00	0.00	6.
1.01	7.30	45	.07	.05	.02	1894.	1.01	17.30	105	0.00	0.00	0.00	6.
1.01	7.40	46	.06	.04	.02	1602.	1.01	17.40	106	0.00	0.00	0.00	6.
1.01	7.50	47	.06	.04	.02	1357.	1.01	17.50	107	0.00	0.00	0.00	6.

1.01	8.00	48	.06	.04	.02	1152.	1.01	18.00	108	0.00	0.00	0.00		6.
1.01	8.10	49	.07	.04	.02	975.	1.01	18.10	109	0.00	0.00	0.00		6.
1.01	8.20	50	.06	.04	.02	833.	1.01	18.20	110	0.00	0.00	0.00		6.
1.01	8.30	51	.06	.04	.02	713.	1.01	18.30	111	0.00	0.00	0.00		6.
1.01	8.40	52	.06	.04	.02	618.	1.01	18.40	112	0.00	0.00	0.00		6.
1.01	8.50	53	.06	.04	.02	543.	1.01	18.50	113	0.00	0.00	0.00		6.
1.01	9.00	54	.06	.04	.02	485.	1.01	19.00	114	0.00	0.00	0.00		6.
1.01	9.10	55	.05	.03	.02	439.	1.01	19.10	115	0.00	0.00	0.00		6.
1.01	9.20	56	.05	.03	.02	400.	1.01	19.20	116	0.00	0.00	0.00		6.
1.01	9.30	57	.05	.03	.02	364.	1.01	19.30	117	0.00	0.00	0.00		6.
1.01	9.40	58	.05	.03	.02	328.	1.01	19.40	118	0.00	0.00	0.00		6.
1.01	9.50	59	.04	.03	.02	293.	1.01	19.50	119	0.00	0.00	0.00		6.
1.01	10.00	60	.04	.03	.02	260.	1.01	20.00	120	0.00	0.00	0.00		6.
									SUM	6.30	4.54	1.76		32985.
										(160.)(	115.)(	45.)(		934.03)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2499.	863.	275.	275.	32953.
CMS	71.	24.	8.	8.	933.
INCHES		4.36	4.63	4.63	4.63
MM		110.81	117.54	117.54	117.54
AC-FT		428.	454.	454.	454.
THOUS CU M		528.	560.	560.	560.

HYDROGRAPH AT STA A1 FOR PLAN 1. RTIO 1

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	8.	14.	29.	55.
95.	147.	212.	294.	411.	621.	943.	1375.	1861.	2250.
2458.	2499.	2396.	2177.	1894.	1602.	1357.	1152.	979.	833.
713.	618.	543.	485.	439.	400.	364.	328.	293.	260.
230.	204.	181.	163.	148.	136.	127.	120.	115.	112.
109.	107.	105.	101.	95.	87.	76.	65.	53.	43.
35.	28.	23.	19.	16.	13.	12.	10.	9.	8.
8.	7.	7.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2499.	863.	275.	275.	32953.
CMS	71.	24.	8.	8.	933.
INCHES		4.36	4.63	4.63	4.63
MM		110.81	117.54	117.54	117.54
AC-FT		428.	454.	454.	454.
THOUS CU M		528.	560.	560.	560.

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HYDROGRAPH ROUTING

ROUTE INFLOW HYDROGRAPH THROUGH IMPOUNDMENT

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	IPAPE	ISTAGE	IAUTO

	A2	1	0	0	0	1	1	0	0

ROUTING DATA

RLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-770.	-1

STAGE	769.59	770.00	770.50	771.00	771.20	771.40	771.60	771.80	772.00	772.50
FLOW	0.00	3.00	8.40	33.00	49.00	132.00	306.00	768.00	1290.00	3101.00
CAPACITY=	145.	175.	221.	254.						
ELEVATION=	770.	771.	772.	773.						

CREL	SPWID	COGW	EXPW	ELEVL	COGL	CAREA	EXPL
769.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
770.5	0.0	0.0	0.

STATION A2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

HO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	.10	1	.17	6.	1.	148.	769.6
1.01	.20	2	.33	6.	1.	148.	769.6
1.01	.30	3	.50	6.	1.	148.	769.6
1.01	.40	4	.67	6.	1.	148.	769.6
1.01	.50	5	.83	6.	1.	148.	769.6
1.01	1.00	6	1.00	6.	1.	148.	769.6
1.01	1.10	7	1.17	6.	1.	148.	769.6
1.01	1.20	8	1.33	6.	1.	149.	769.6
1.01	1.30	9	1.50	6.	1.	149.	769.6
1.01	1.40	10	1.67	6.	1.	149.	769.6
1.01	1.50	11	1.83	6.	1.	149.	769.6
1.01	2.00	12	2.00	6.	1.	149.	769.6
1.01	2.10	13	2.17	6.	1.	149.	769.6
1.01	2.20	14	2.33	6.	1.	149.	769.6
1.01	2.30	15	2.50	6.	1.	149.	769.6
1.01	2.40	16	2.67	6.	1.	149.	769.6
1.01	2.50	17	2.83	6.	1.	149.	769.6
1.01	3.00	18	3.00	6.	1.	149.	769.6
1.01	3.10	19	3.17	6.	1.	149.	769.6
1.01	3.20	20	3.33	6.	1.	149.	769.6
1.01	3.30	21	3.50	6.	1.	149.	769.6
1.01	3.40	22	3.67	6.	1.	149.	769.6
1.01	3.50	23	3.83	6.	1.	150.	769.7
1.01	4.00	24	4.00	6.	1.	150.	769.7
1.01	4.10	25	4.17	6.	1.	150.	769.7
1.01	4.20	26	4.33	6.	1.	150.	769.7
1.01	4.30	27	4.50	8.	1.	150.	769.7
1.01	4.40	28	4.67	14.	1.	150.	769.7
1.01	4.50	29	4.83	29.	1.	150.	769.7
1.01	5.00	30	5.00	65.	1.	151.	769.7
1.01	5.10	31	5.17	95.	1.	152.	769.7
1.01	5.20	32	5.33	147.	2.	153.	769.8

1.01	5.30	33	5.50	212.	2.	156.	769.9
1.01	5.40	34	5.67	294.	3.	159.	770.0
1.01	5.50	35	5.83	411.	4.	164.	770.1
1.01	6.00	36	6.00	621.	7.	171.	770.4
1.01	6.10	37	6.17	943.	10.	182.	770.7
1.01	6.20	38	6.33	1375.	58.	197.	771.2
1.01	6.30	39	6.50	1861.	720.	214.	771.8
1.01	6.40	40	6.67	2250.	1763.	225.	772.1
1.01	6.50	41	6.83	2458.	2272.	230.	772.3
1.01	7.00	42	7.00	2499.	2449.	232.	772.3
1.01	7.10	43	7.17	2386.	2444.	232.	772.3
1.01	7.20	44	7.33	2177.	2304.	230.	772.3
1.01	7.30	45	7.50	1854.	2073.	228.	772.2
1.01	7.40	46	7.67	1602.	1793.	226.	772.1
1.01	7.50	47	7.83	1357.	1523.	223.	772.1
1.01	8.00	48	8.00	1152.	1292.	221.	772.0
1.01	8.10	49	8.17	979.	1124.	219.	771.9
1.01	8.20	50	8.33	833.	963.	217.	771.9
1.01	8.30	51	8.50	713.	823.	216.	771.8
1.01	8.40	52	8.67	618.	718.	214.	771.8
1.01	8.50	53	8.83	543.	635.	213.	771.7
1.01	9.00	54	9.00	485.	562.	212.	771.7
1.01	9.10	55	9.17	439.	502.	211.	771.7
1.01	9.20	56	9.33	400.	454.	210.	771.6
1.01	9.30	57	9.50	364.	412.	209.	771.6
1.01	9.40	58	9.67	328.	378.	209.	771.6
1.01	9.50	59	9.83	293.	350.	208.	771.6
1.01	10.00	60	10.00	260.	319.	207.	771.5
1.01	10.10	61	10.17	230.	288.	206.	771.5
1.01	10.20	62	10.33	204.	258.	206.	771.5
1.01	10.30	63	10.50	181.	231.	205.	771.5
1.01	10.40	64	10.67	163.	206.	204.	771.5
1.01	10.50	65	10.83	148.	185.	204.	771.4
1.01	11.00	66	11.00	136.	167.	203.	771.4
1.01	11.10	67	11.17	127.	152.	203.	771.4
1.01	11.20	68	11.33	120.	140.	203.	771.4
1.01	11.30	69	11.50	115.	131.	203.	771.4
1.01	11.40	70	11.67	112.	129.	202.	771.4
1.01	11.50	71	11.83	109.	126.	202.	771.4
1.01	12.00	72	12.00	107.	123.	202.	771.4
1.01	12.10	73	12.17	105.	120.	202.	771.4
1.01	12.20	74	12.33	101.	118.	202.	771.4
1.01	12.30	75	12.50	95.	115.	201.	771.4
1.01	12.40	76	12.67	87.	111.	201.	771.3
1.01	12.50	77	12.83	76.	107.	201.	771.3
1.01	13.00	78	13.00	65.	101.	200.	771.3
1.01	13.10	79	13.17	53.	94.	200.	771.3
1.01	13.20	80	13.33	43.	87.	199.	771.3
1.01	13.30	81	13.50	35.	80.	199.	771.3
1.01	13.40	82	13.67	28.	72.	198.	771.3
1.01	13.50	83	13.83	23.	65.	198.	771.2
1.01	14.00	84	14.00	19.	58.	197.	771.2
1.01	14.10	85	14.17	16.	51.	197.	771.2
1.01	14.20	86	14.33	13.	48.	196.	771.2
1.01	14.30	87	14.50	12.	47.	196.	771.2
1.01	14.40	88	14.67	10.	46.	195.	771.2
1.01	14.50	89	14.83	9.	45.	195.	771.1
1.01	15.00	90	15.00	8.	44.	194.	771.1
1.01	15.10	91	15.17	8.	42.	194.	771.1
1.01	15.20	92	15.33	7.	41.	194.	771.1

1.01	15.30	93	15.50	7.	40.	193.	771.1
1.01	15.40	94	15.67	6.	39.	193.	771.1
1.01	15.50	95	15.83	6.	38.	192.	771.1
1.01	16.00	96	16.00	6.	37.	192.	771.0
1.01	16.10	97	16.17	6.	36.	191.	771.0
1.01	16.20	98	16.33	6.	35.	191.	771.0
1.01	16.30	99	16.50	6.	34.	191.	771.0
1.01	16.40	100	16.67	6.	33.	190.	771.0
1.01	16.50	101	16.83	6.	32.	190.	771.0
1.01	17.00	102	17.00	6.	32.	190.	771.0
1.01	17.10	103	17.17	6.	31.	189.	771.0
1.01	17.20	104	17.33	6.	31.	189.	771.0
1.01	17.30	105	17.50	6.	30.	189.	770.9
1.01	17.40	106	17.67	6.	30.	188.	770.9
1.01	17.50	107	17.83	6.	29.	188.	770.9
1.01	18.00	108	18.00	6.	29.	188.	770.9
1.01	18.10	109	18.17	6.	28.	187.	770.9
1.01	18.20	110	18.33	6.	28.	187.	770.9
1.01	18.30	111	18.50	6.	27.	187.	770.9
1.01	18.40	112	18.67	6.	27.	186.	770.9
1.01	18.50	113	18.83	6.	26.	186.	770.9
1.01	19.00	114	19.00	6.	26.	186.	770.9
1.01	19.10	115	19.17	6.	25.	186.	770.8
1.01	19.20	116	19.33	6.	25.	185.	770.8
1.01	19.30	117	19.50	6.	25.	185.	770.8
1.01	19.40	118	19.67	6.	24.	185.	770.8
1.01	19.50	119	19.83	6.	24.	185.	770.8
1.01	20.00	120	20.00	6.	23.	184.	770.8

PEAK OUTFLOW IS 2449. AT TIME 7.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2449.	784.	254.	254.	30451.
CMS	69.	22.	7.	7.	862.
INCHES		3.96	4.28	4.28	4.28
MM		100.64	108.62	108.62	108.62
AC-FT		389.	419.	419.	419.
THOUS CU M		479.	517.	517.	517.

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00
HYDROGRAPH AT	A1	1.84	1	2499.
		(4.77)		(70.76)(
ROUTED TO	A2	1.84	1	2449.
		(4.77)		(69.36)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	769.60	769.50	770.50
STORAGE	148.	145.	175.
OUTFLOW	1.	0.	8.

RATIO	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	772.32	1.82	232.	2449.	14.00	7.00	0.00

APPENDIX 5

REFERENCES

COZY LAKE DAM

APPENDIX 5

REFERENCES

COZY LAKE DAM

1. U.S. Army Corps of Engineers, Hydrologic Engineering Center, "Flood Hydrograph Package (HEC-1) for Dam Safety Inspections-User's Manual," Davis, California, September, 1978.

2. Brater, Ernest F. and King, Horace, Handbook of Hydraulics, Sixth Edition, McGraw-Hill, New York, 1976.

3. U.S. Bureau of Public Roads, "Design Charts for Open Channel Flow," October 1960.

4. Reference Data, Dams in New Jersey, No.22-33 from New Jersey Department of Environmental Protection files, dated November 18, 1924.

5. "Workshop Notes on Storm Sewer System Design," Editied by Ben Chie Yen, Dep. of Civil Engineering, Univ. of Illinois at Urbana-Champaign, 1978.

6. Schwab, G.O., R.K. Frevert, T.W. Edmister, and K.K. Barnes, Soil and Water Conservation Engineering, The Ferguson Foundation Agricultural Engineering Series, John Wiley and Sons, Inc., New York, 1966, 683 pp.

7. United States Department of Interior, Bureau of Reclamation, Design of Small Dams, U.S. Government Printing Office, Washington, 1977, 816 pp.

8. U.S. Department of Interior, Geological Survey, 7.5-Minute Series (topographic) maps, scale 1:24000, Contour Interval 20 feet: Franklin, N.J., (1954), and Newfoundland, N.J. (1954).

9. National Oceanic and Atmospheric Administration, Technical Memorandum National Weather Services Hydro-35, June, 1977.

10. U.S. Department of Commerce, Weather Bureau - Technical Paper No. 40. Rainfall Frequency Atlas of U.S.A. for Durations from 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years, May, 1961.

11. Lewis, J.V. and H.B. Kummel (1910-1912) Geologic Map of New Jersey, revised by H.B. Kummel, 1931, and by M.E. Johnson, 1950. New Jersey Department of Conservation and Economic Development Atlas, Sheet 40.